

# Quality Control Costs in Brazilian Spatial Data Production

Simone Sayuri Sato, André Luiz Sá de Oliveira, Alex Jailson Barbosa Andrade, Renisson Neponuceno de Araújo Filho, Alex da Penha

Pernambuco Federal University, Technology and Earth Sciences Center, Cartographic Engineering Department. Recife City –Pernambuco State – Brazil.

**Abstract.** The speed to collect, treat and provide data for mapping today, is a crucial factor when it comes to creating and maintaining cartographic databases. However, it is common in the acquisition phase of geospatial data they have not clearly defined their specific techniques for the purpose it was intended or even control the evaluation of their qualities, significantly compromising the integrity and accuracy of such products. The aim of this study was to understand how to evaluate and interpret spatial data quality produced by mapping companies in Brazil. Results showed provided a brief diagnostic on the current situation of the companies related to the mapping of quality control of cartographic products and portrayed that need the knowledge and deepening by companies on issues of norms and technical specifications within the national cartography and that is requires the presence of trained technical personnel in institutions for the development, supervision and approval of products and services specified in the existing national technical rules.

**Keywords:** data quality, spatial data, cartography

## 1. Introduction

Brazilian cities grow overly cluttered and so even in the face of so many laws, decrees and regulations regarding land use planning and then. The

challenge is to keep up the momentum space to plan and supervise the scope of environmental issues, the use and occupation of urban land.

Among the various forms of monitoring are geotechnologies with the use of geospatial data. Noticed is that more and more interest in geo spreads and access in recent decades and therefore the use of these technologies has been magnified by the costs more affordable in cartography.

The use of geotechnologies is considered extremely effective in many aspects, both for planning interventions as efficient tools for measurement, analysis, evaluation and description of the natural environment altered or as a way to strategic management. They are also used for the purpose in supporting environmental monitoring control measures to combat or mitigate the effects degradational, enabling a systemic understanding of the organization of geographical space (Cunha, 2006).

In recent years, much has been discussed about the ways we can facilitate the process of acquisition of these data in order to minimize costs and reduce the execution time of the mappings. The speed to collect, treat and provide data for mapping so you can make today, is a crucial factor when it comes to creating and maintaining cartographic databases.

Technological advances and computational tools geotechnologies made possible the design of cartographic products for better accuracy. However, it is common in the acquisition phase of geospatial data they have not clearly defined their specific techniques for the purpose it was intended or even control the evaluation of their qualities, significantly compromising the integrity and accuracy of such products. With that the quality of cartographic basis is unsupported and favoring failure in GIS (Oliveira, 2004).

Even so, note that currently, in many cases, users are buying digital maps without effecting quality control procedures with appropriate review and validation through the errors of inconsistencies, according to the purpose of spatial data and the level of quality the final product. The research conducted at national and international bibliography to guide the definition of the criteria for sampling and quality assurance, demonstrated the lack of methodologies and standards, official or not fully established, valid and applicable to the case. There is some technical work undertaken for other scales, to a single letter, or for small areas such as test pilot in the academic and not for large scale production (Santos et al., 2008).

This study objective was to understand how evaluate and interpret the quality of spatial data produced by mapping companies in Brazil.

## **2. Materials and Methods**

Interviews were conducted in companies located in Brazil, in September-October 2012 for direct observation of the state of data quality spatial study, using the tool of electronic questionnaires via Internet called Survey Mon-

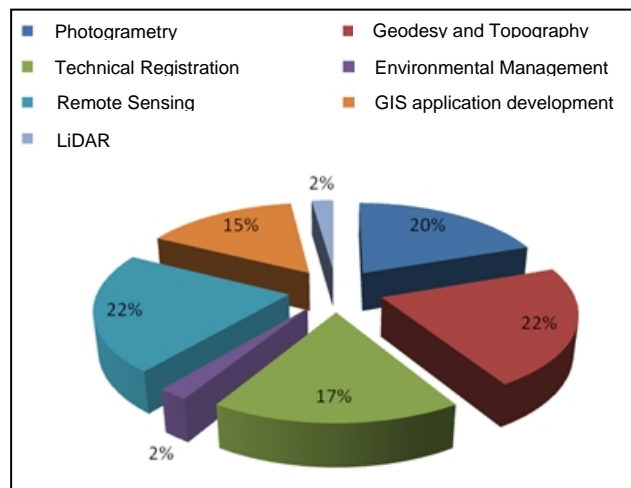
key. At first, we conducted interviews favoring a quickly diagnostics participatory of public and private companies.

The interviews conducted by electronic questionnaire, with definition of the survey, establishment of sampling and measurement techniques of data collection. Sampling set to a questionnaire was non probabilistic intentional, where the sample is determined by the researcher and the interviewer goes to a specific group to know your opinion, having a prior knowledge of the population and their proportionality (Levin, 1978; Mattar, 1999). The groups chosen for interview were responsible for experiencing the constant and dynamic changes in the insertion of data quality in business management. The instrument used to perform the interviews was planned at the structured questionnaire containing questions. Subsequently was mounted a tabulation data in Microsoft Excel for treatment and analysis, so becoming more complete and easy to interpret. We conducted a total of 10 interviews during the months of September and October 2012.

### 3. Results and Discussions

#### 3.1. Operational Companies Areas

According to the results of the questionnaires, most companies working with Remote Sensing, Geodesy and Topography corresponding totaling 22%, with 20% of following those working with Photogrammetry, joined technician with 17% of applications GIS with 15%, and the remaining areas are less expressive applications (see *Figure 1*).

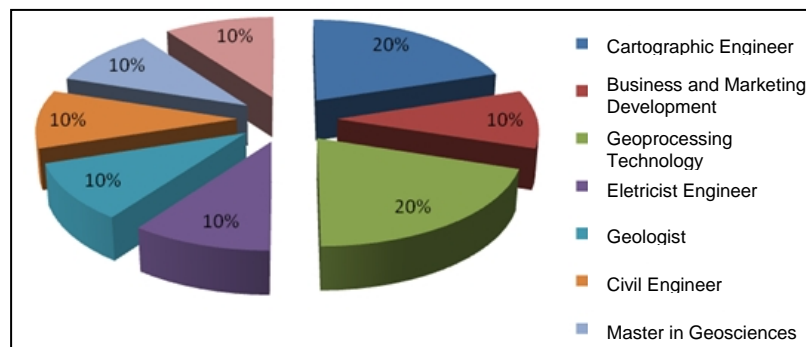


**Figure 1.** Area of expertise of the companies surveyed

According to the above, it is clear that most of the surveyed companies active in the area of data collection in a variety of acquisition techniques of spatial data, which is justified by the high demand update cartographic databases and be one step costs are relatively high, which depends on manpower trained and qualified to ensure that the quality in the initial stage of data acquisition.

### 3.2. Professionals Profiles

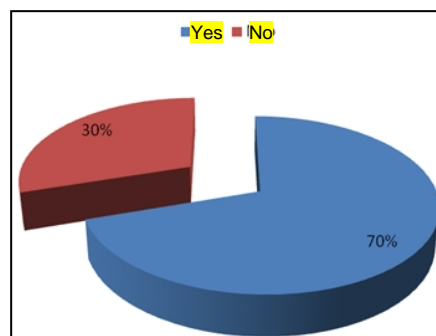
Regarding the professionals profiles who work directly with quality control, is the Cartographic Engineer and Geoprocessing Technologist, that by the very nature of the training that is issues for geospatial professionals and the remaining is evenly distributed 10%. (see *Figure 2*).



**Figure 2.** Professional Profiles

### 3.3. Customers consultation who stopped business services

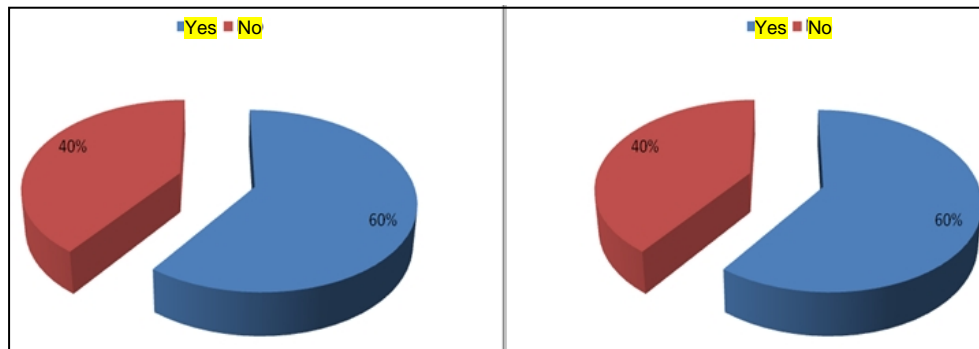
Between firms surveyed, 70% answered that query ram m customers who fail to request the products without any justification and the other said no consult. This fact may be associated with the delivery of the product or of low quality because customer find other companies with competing proposals cost more viable.



**Figure 3.** Companies that query the customer who fails to request their services

### 3.4. Comparison of the results with the expected realization made by the company and the statistical control

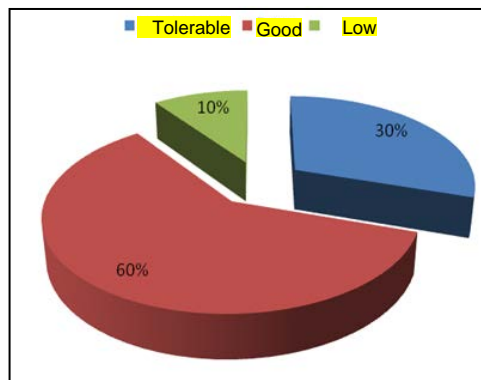
More than half of companies surveyed compare the results achieved with those who were estimated at the beginning of projects, leading to a scenario that the market producer spatial data concerned with quality control. But there is still a significant percentage of companies that do not perform this procedure, about 40% of organizations, leading to a failure of vision or even the lack of planning and business management. The lack of statistical control reported by 40% of companies surveyed may compromise the planning of future actions. Suggest the application of these companies management tool called *PDCA (Plan To, To Do, To Check, To Act)*.



**Figure 4.** Companies that compare the results achieved with the planned and Realization of Statistical Control

### 3.5. Process of quality evaluation by company's management

Process evaluation of quality management for certain parts of companies 60% has a good management process while 30% is tolerable and 10% is low, which concludes that all departments and sectors of businesses are directly or indirectly committed to quality control.

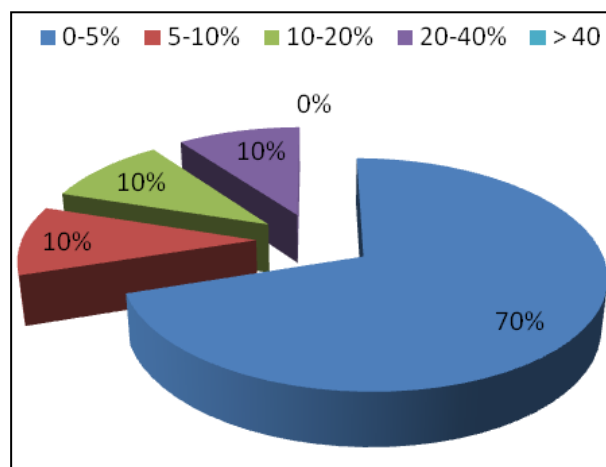


**Figure 5.** Quality assessment by the Director of Business

### 3.6. Cost for the Geospatial data quality control

About 70% of companies provides 0-5% of the financial resources to control what age. That margin of resources available, 50% of companies recognize that this value is low.

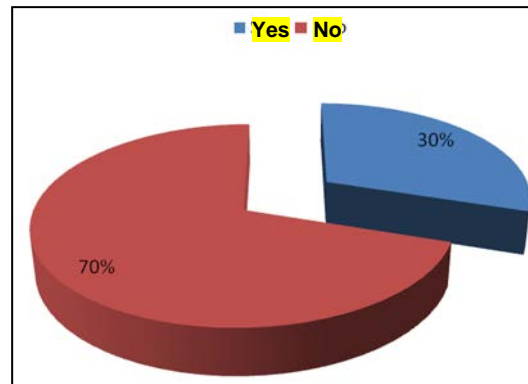
It is noticed that the still low number of companies planning to invest resources and budget with quality control, which may cause future losses in case of failure of services by audit activities and validation of data, causing companies to allocate funds extras for corrections, revisions and reambulação. Besides the time spent to fulfill the tasks, compromising accuracy temporal data.



**Figure 6.** Percentage of Cost for the quality control of Geospatial Data

### 3.7. Customer Service Department

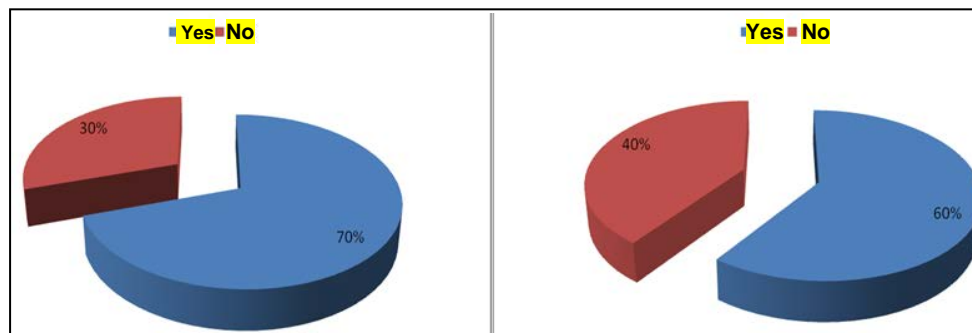
The question was raised whether the company have owned a service in customer service, where 70% of those companies that do not have this service and 30% said they have it. This is alarming because the client does not have a technical support answer your questions or report possible errors produced. Companies could provide an electronic service via internet, email, chat online or via phone to improve the level of customer relationship x company.



**Figure 7.** Availability Service Customer Service

### 3.8. Implementation of quality management and Existence of a quality control department in companies

Throughout the questionnaire, was asked if companies apply the management of spatial data quality and 70% of the replies that effecting such management, and 60% of them responded that there is a specific sector to address and implement quality control data. It is a very positive result in terms of the companies are with a view toward the production quality of spatial information, ensuring and guaranteeing the quality of information geospatial reference and overseeing best all guidelines and procedures to ensure the same qualities in default adopted by companies.

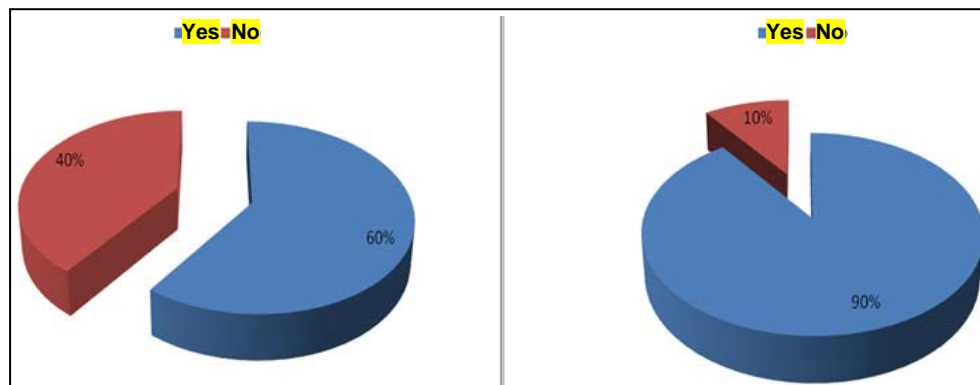


**Figure 8.** Implementation of Quality Management and Existence of a quality control department in companies

### 3.9. ISO Certification

Of the companies surveyed, 60% are certified by ISO and the remaining 40% do not have such certification. It was found that even with this result, 90% of them have the methodologies s internal control process quality. The current situation of companies without certification is still high. These companies need to ensure implementation of cartographic quality, guiding

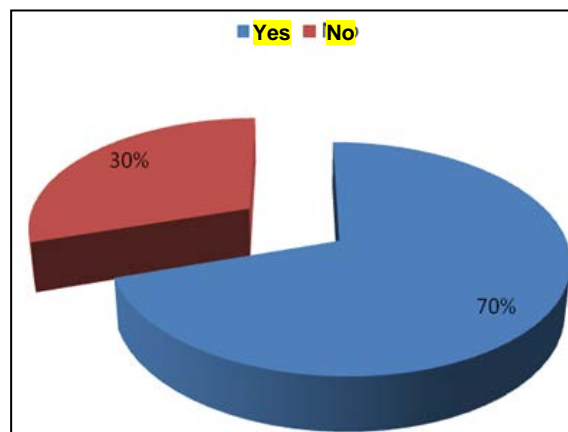
the development of their spatial data infrastructure that allows building and empowering the use and management of geographic information as and can thus undergo certification of paramount importance for guarantee a product with desired quality.



**Figure 9.** Certification of Companies for ISO Stocks and internal methods of quality control

### 3 .10. Financial return by investing in quality

Even companies not investing a good percentage of financial management for quality control, as specified in 4.6. item, they get financial returns by investing in data quality management. According to Figure 10, there are 70% of companies in a financial return to invest in quality.

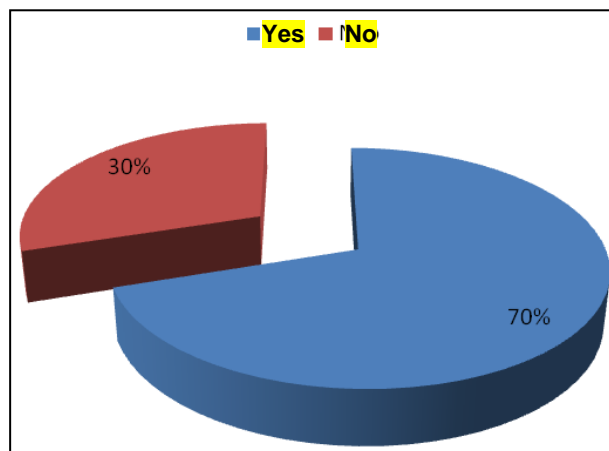


**Figure 10.** Financial return by investing in quality



### 3.11. Management of data and metadata politic in business

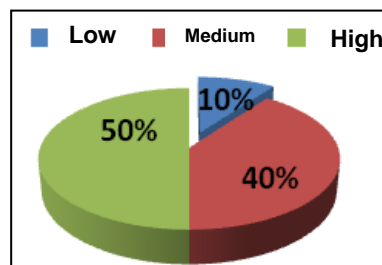
It is observed in *Figure 11* that 70% of companies surveyed have a policy for managing data and metadata. According Lisboa Filho (1999), the quality of spatial information and its products is multidimensional and complex, varying spatially and temporally. The production and use of metadata faces certain difficulties technical-operational due to problems of quality, quantity, description and durability. The deployment of metadata on a large scale has some limitations related to hardware and software, as regards the form of information storage and coding program development and production of metadata.



**Figure 11.** Management of data and metadata politic in companies

### 3.12. Satisfaction Level

Fence 50% of respondents declared that the ram satisfaction after the implementation of data quality in business was much better features and data security, bringing benefits to the company and the contractor (*Figure 12*).

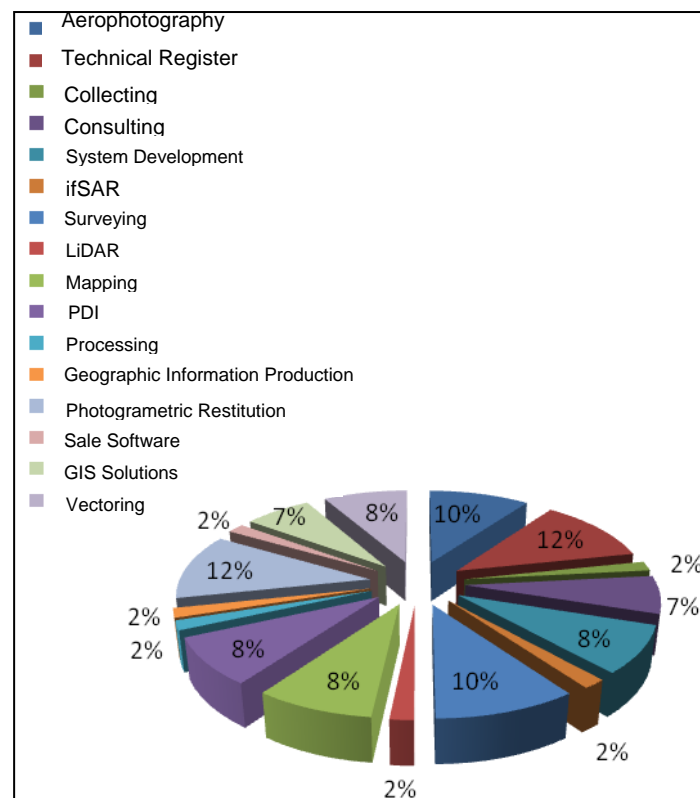


**Figure 12.** Satisfaction Level of companies to compare results with expected

It is observed that the deployment of data quality in business brought favorable conditions for companies exercising their economic activities, which indicated improved working conditions and basemap. Companies that have deployed nationally noteworthy, wean with its contradiction.

### 3.13. Traditional Techniques Activities

Regarding the traditional technical activities organizations, Photogrammetric Restitution were the most reported with 12% of companies followed by Technical Register also 12%. The activities are carried Aerophotography by 10% of them. Countryside Survey showed 10%. Followed by Vectoring (8%), Systems Development (8%), Mapping (8%) and PDI (8%). Consulting Services are performed by 7% of businesses and GIS Solutions was also reported by 7% of them. Collection activities were reported by only 2%, followed by processing (2%) and Geospatial Information Production (2%), IFSAR (2%), LiDAR (2%) and sale software (2%), according with the chart below.



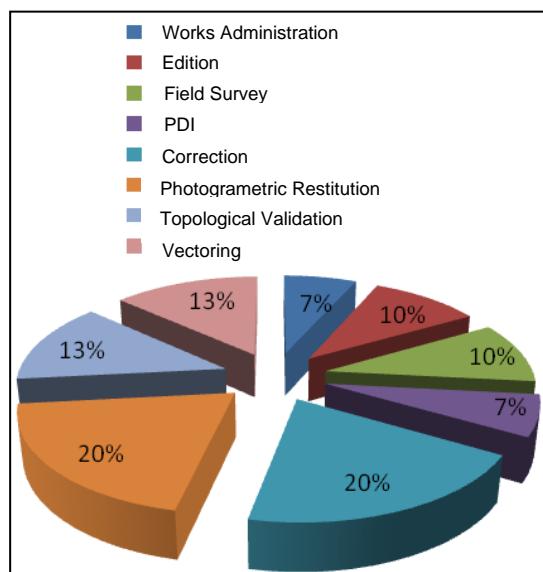
**Figure 13.** Traditional Techniques Activities in companies

Restitution activities requires the operator special attention and a high level of training for it has perceptive ability to interpret the objects in the image

acquired power and restore them on a scale compatible with what is proposed. The activity requires a good technical record of commitment to that field teams blunders and accidental are not made in the process of data collection. The activities of acquiring LiDAR and ifSAR data showed a low percentage due to the cost of such equipment is quite high and skilled labor is still a bit sparse.

### 3.14. Harder activities to implement, to test and to monitor the quality

About the activities that companies were more difficult to implement, test and monitor quality control. 20% of companies responded that correction activity is more comprehensive and equating with Photogrammetric Restitution activities which was also reported by 20% of firms, while 13% consider more difficult to monitor the quality of Vectoring, matching with Topological Validation (13%). Edition showed 10% of companies and Survey Field also were cited by 10% of companies and found that only 7% Works administration activities and PDI (7%) are more complex to ensure data quality, explained in the *Figure 14*.



**Figure 14.** Harder activities to implement, to test and to monitor the quality

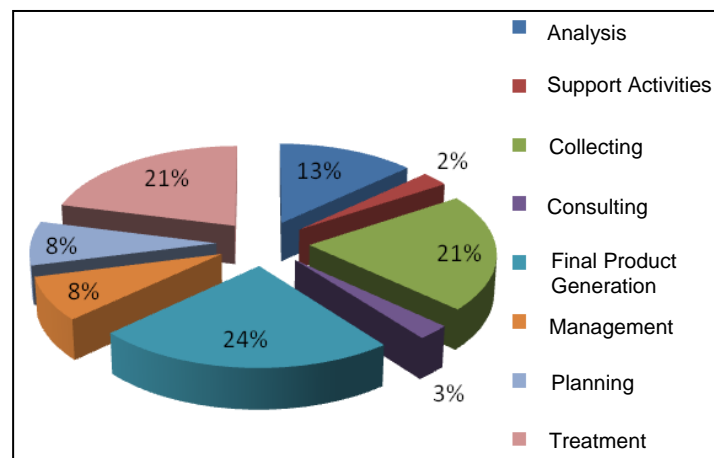
The Photogrammetric Restitution besides being difficult to implement, is quite a task exhaustive and requires close attention to the operator not to leave the area or repay any detail. In most tenders for hiring of services for

mapping, photogrammetric restitution is sought and requires quite a quality standard that includes the steps of restitution.

### 3.15. Steps which are conducted in the quality control

It was also questioned about what steps they are made quality control. Most of them said that quality control is performed steps of the final product generation (24%), treatment (21%) and Data Collection (21%), while 13% of companies reported that they control step in the analysis, followed by management (8%) and Planning (8%). The feathers 3% of organizations performing quality control phase of Consulting and 2% in phase support.

This result shows that most companies prefer to confer the status of their products in the final stage, the stage of delivery to the customer. If organizations concern themselves with the quality management from the stage of action planning and gathering, the end result would certainly be an excellent quality product for having applied the specifications and standards of quality control from the beginning. The table also shows that few companies apply quality control in the planning phase. It is necessary that the managers responsible for production of geoinformation violate the necessity of use of quality control are made at all stages of production, ranging from planning, and data collection until the generation of the final product.

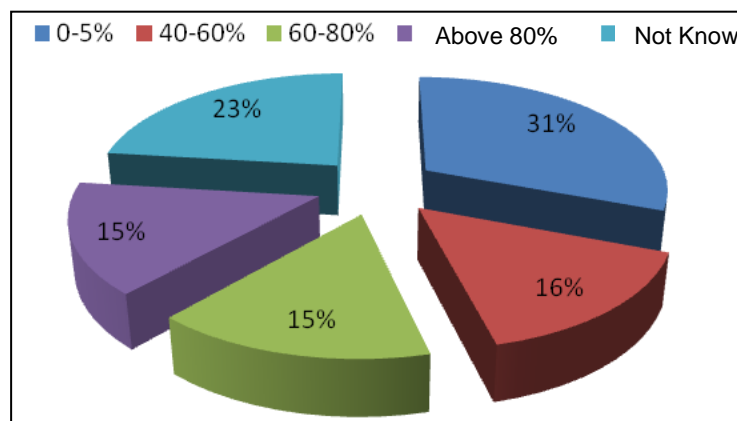


**Figure 15.** Steps in which is performed the quality control

### 3.16. Percentage of data produced by the companies according the INDE standard specifications

It was asked if the percentage ratio of standard spatial data produced with the standard specified by INDE – Brazilian Infrastructure National Spatial Data. It was found that a considerable part of the sample, 31% of companies consider that 0-5% of data are produced in the pattern of INDE while 23% did not know to response. Are framed from 40% to 60% of the data produced by 16% of companies, 60% to 80% for 15% of companies and 15% said that more than 80% of data are produced in standard INDE.

It is observed that more than half of companies do not adopt the national standard for spatial data structure. Figure 16 shows that it is still worrying that the number of companies still has little or no knowledge of the INDE. Although the project INDE be a relatively new nationwide with estimated total implementation of action plans by the year 2020, there is no oversight of the companies to investigate compliance with the standards and specifications set by CONCAR – Brazilian National Cartography Commission - for the promotion the appropriate land in the generation, storage, access, sharing, dissemination and use of geospatial data. Thus, the objective is also to avoid duplication of efforts and waste of resources in obtaining geospatial data through the dissemination of documentation (metadata) of data available in public entities and organs of federal, state and municipal.

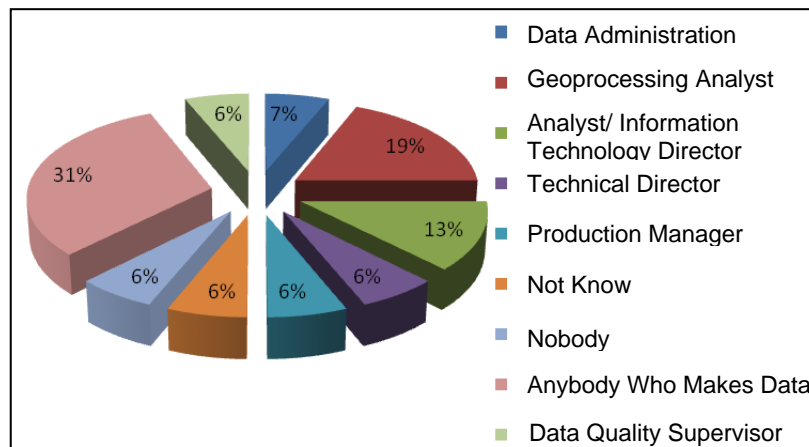


**Figure 16.** Percentage of data produced by the companies to the standard specified by INDE

### 3.17. Professionals responsible for spatial data quality in companies

It was investigated the person who is responsible for spatial data quality produced by the company. 31% of companies blame anyone who is produc-

ing the data, while 19% answered that the GIS Analyst is the person responsible for quality. The Analyst/Director of Information Technology was cited by 13% and 7% of companies said that the Data Administrator performs this function. Followed by Technical Director (6%), Production Manager (6%) and Supervisor (6%) are responsible for the quality. 6% no answer and a further 6% of companies said that there is no human resource available to assume responsibility for data quality.



**Figure 17.** Professionals responsible for spatial data quality in companies

Although the professionals who work with the production of spatial data are engineers and cartographers in GIS technologists, as explained in section 4.2, any person working with the production data can be responsible for data quality. It is necessary to have a technical manager-specific training and operating with full knowledge of ISO standards and INDE so that the company actually has a policy of management of quality control. There are still companies that do not have professionals to take responsibility for quality, featuring a lack of organizational structure for the company, which can cause customer dissatisfaction in the lack of quality in the production of their data.

## 4. Conclusion

The multiple demands by the requirement of spatial data quality are configured as a typical picture of the conflict by the use of this tool by companies.

Research on quality of data provided a brief diagnostic the current situation of the companies related to the control of the quality of cartographic products and portrayed that you need the knowledge and deepening by compa-

nies on issues of norms and technical specifications within the cartography national.

An important point to note is that apart from the need to follow the existing rules and laws requires the presence of trained technical personnel in institutions for the development, supervision and approval of products and services specified in the existing national technical rules.

The standardization of CONCAR for Quality Control of Geospatial Data is still being drafted, but still have available for cartographic products PEC - Cartographic Accuracy Standards as well as parameter is now also available PAP-PCD (Pattern and Accuracy Precision Products for Digital Cartographic) among other standards specified in their applications. In the absence of technical specifications is important to discriminate well the methodology adopted in accordance with the existing rules and laws and especially to monitor and validate the products according to them.

The results presented brought a general abundance procedures performed by mapping companies to try to ensure a satisfactory quality in spatial data acquisition. To better recommend further studies were varied cases of successful companies that can assist in developing a national standardization of testing procedures with quality.

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